FORM PTO-1390 (REV. 5-93) | U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE | ATTORNEY'S DOCKET NUMBER 10191/1694

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/720938

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATES CLAIMED
PCT/DE99/01869	(26.06.99) 26 June 1999	(30.06.98) (25.05.99) 30 June 1998 25 May 1999

TITLE OF INVENTION
APPARATUS FOR SENSING ELECTROMAGNETIC RADIATION

APPLICANT(S) FOR DO/EO/US
ROTHLEY, Manfred; MUELLER-FIEDLER, Roland; ZABLER, Erich; ERDMANN, Lars; LENEKE, Wilhelm; SIMON, Marion; STORCK, Karlheinz; and SCHIEFERDECKER; Joerg

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (unsigned)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: Copies of International Search Report, Preliminary Examination Report and Form PCT/RO/101.

EXPRESS NO. EL302 702659

526 Rec'd PCT/PTO 02 JAN 2001

U.S. APPLICATION NO (if known, see 37 CFR 1.5) 09/720938	INTERNATIONAL APPLICATION NO PCT/DE99/01869	ATTORNEY'S DOCKET NUMBER 10191/1694

17. ☒ The following fees are submitted:

CALCULATIONS | PTO USE ONLY

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search Report has been prepared by the EPO or JPO $860.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) ... $690.00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $710.00

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,000.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =				$860	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	18 - 20 =	0	X $18.00	$	
Independent Claims	2 - 3 =	0	X $80.00	$	
Multiple dependent claim(s) (if applicable)			+ $270.00	$	
TOTAL OF ABOVE CALCULATIONS =				$860	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$860	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$860	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$860	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$860.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Kenyon & Kenyon
One Broadway
New York, New York 10004

by: [signature] (Reg. No. 36,098)

SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

2 January 2001
DATE

339339

[10191/1694]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)	:	Manfred ROTHLEY et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	APPARATUS FOR SENSING ELECTROMAGNETIC RADIATION
Examiner	:	To Be Assigned
Art Unit	:	To Be Assigned

Assistant Commissioner
for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

SIR:

Kindly amend the above-identified application before examination, as set forth below.

IN THE TITLE:

Please replace the title with the following new title: --APPARATUS FOR SENSING ELECTROMAGNETIC RADIATION--.

IN THE SPECIFICATION:

Please amend the specification as follows:

On page 1, before line 1, insert: --FIELD OF THE INVENTION--.

On page 1, line 1, after "The" insert --present--.

On page 1, line 2, change "resolution, as defined in" to --resolution.--.

EL302 702659

On page 1, delete line 3.

On page 1, delete line 5.

On page 1, before line 7, insert: --BACKGROUND INFORMATION--.

On page 1, line 7, change "Present-day" to --Conventional--.

On page 1, delete line 31.

On page 1, before line 33, insert: --SUMMARY--.

On page 1, line 33, change "In contrast thereto, it is the object of the invention to" to --An object of the present invention is to--.

On page 2, line 11, change "a development of the" to --an advantageous embodiment of the present--.

On page 2, line 28, change "In a development of this embodiment, the" to --The--.

On page 2, line 29, change "are differently" to --may be, for example,--.

On page 2, line 30, change "oriented," to --oriented differently,--.

On page 2, line 35, change "example once again" to --example,--.

On page 3, line 1, change "development of the" to --embodiment of the present--.

On page 3, line 8, change "is" to --may--.

On page 3, line 9, change "thus preferably" to --be--.

On page 3, line 12, change "certainly also conceivable;" to --also possible;--.

On page 3, line 14, change "via" to --using--.

On page 3, line 18, change "join" to --joins--.

On page 3, line 39, change "is" to --may be--.

On page 3, line 40, delete "preferably".

On page 4, line 13, before "invention" insert --present--.

On page 4, line 17, delete "previous".

On page 4, line 18, change "spacers," to --spacers described above,--.

On page 4, line 22, delete "already" and ",".

On page 4, line 31, before "invention," insert --present--.

On page 4, line 36, change "would be, so to speak, the most highly" to --provides--.

On page 4, delete line 37.

On page 4, line 38, delete "correspondingly".

On page 5, line 4, change "must" to --should--.

On page 5, line 7, change "known" to --conventional--.

On page 5, line 8, change "it is advisable to construct a membrane made," to --a membrane may be constructed of,--.

On page 5, line 9, delete "of".

On page 5, delete line 19-23.

On page 5, before line 25, insert: --BRIEF DESCRIPTION OF THE DRAWINGS--.

On page 5, line 26, change "variant embodiment of the invention;" to --example embodiment of the present invention.--.

On page 5, line 29, change "variant embodiment;" to --example embodiment of the present invention.--.

On page 5, line 31, change "variant" to --example--.

On page 5, line 32, change "embodiment;" to --embodiment of the present invention.--.

On page 5, line 34, change "a further embodiment of the invention" to --another example embodiment of the present invention--.

On page 5, line 35, change "construction; and" to --construction.--.

On page 5, line 37, change "a particular embodiment" to --an example embodiment of the present invention--.

On page 6, before line 1, insert: --DETAILED DESCRIPTION--.

On page 6, line 22, change "The developed exemplary embodiment in Figure 2 shows once" to --Figure 2 shows--.

On page 6, line 23, change "again an apparatus 1 according to the present invention," to --an apparatus 1 according to a second embodiment of the present invention. In Figure 2,--.

On page 6, line 24, change "being" to --is--.

On page 6, line 26, change "In this Figure, a cavity 8 is indicated" to --A cavity 8 is shown--.

On page 7, line 11, change "Here as in the aforementioned" to --Here, as in the above-described--.

On page 7, line 24, change "must be" to --is--.

On page 7, line 28, change "all" to --any appropriate--.

On page 7, line 29, change "are available" to --may be used--.

On page 7, line 32, delete "The depiction in".

On page 7, line 40, change "case it is important" to --case,--.

On page 8, line 1, delete "to ensure that".

On page 8, line 4, delete "it would be suitable, for".

On page 8, line 5, change "example, to use silicon as the substrate material. Silicon" to --silicon, for example, may be used as the substrate material. Silicon may also--.

On page 8, line 6, change "would furthermore also be a suitable material" to --be used--.

On page 8, line 7, change "mentioned earlier," to --described above,--.

On page 8, line 33, change "are preferably" to --may be--.

On page 9, delete line 1, and insert: --What Is Claimed Is:--.

IN THE ABSTRACT:

Please amend the abstract as follows:

Line 3, change "The present invention proposes an apparatus (1) to --An apparatus--.

Line 6, change "installed. This is achieved, according to the present" to --installed is described. This is achieved--.

Line 7, delete "invention,".

Line 8, delete "(5)".

IN THE CLAIMS:

Please cancel, without prejudice, claims 1-18 in the underlying PCT application.

Please also cancel, without prejudice, revised claim 1 in the annex to the International Preliminary Examination Report.

Please add the following new claims:

19. (New) An apparatus for sensing electromagnetic radiation, comprising:

a detector structure to sense electromagnetic radiation, the detector structure formed on a semiconductor substrate;

a protective window for the detector structure, and

a micromechanically producible image-producing optical imaging system forming an image of a subject onto a plane of the detector structure.

20. (New) The apparatus according to claim 19, wherein the optical imaging system includes a micromechanically producible lens.

21. (New) The apparatus according to claim 19, wherein the optical imaging system is rigidly joined to the detector structure.

22. (New) The apparatus according to claim 19, wherein the detector structure includes multiple separate detector elements and the imaging system includes multiple lenses, each lens of the multiple lenses being associated with a respective one of the detector elements.

23. (New) The apparatus according to claim 19, wherein the detector structure includes multiple separate detector elements and the imaging system includes multiple lenses, wherein at

least one of the multiple lenses is provided for a group of the detector elements.

24. (New) The apparatus according to claim 19, wherein the optical imaging system forms the protective window.

25. (New) The apparatus according to claim 19, further comprising:

a protective housing, the optical imaging system being set into the protective housing.

26. (New) The apparatus according to claim 19, further comprising:

spacers provided between the substrate of the detector structure and the optical imaging system.

27. (New) The apparatus according to claim 19, wherein the detector structure includes multiple separate detector elements, the detector elements being separated from one another by optical partitions.

28. (New) The apparatus according to claim 27, wherein the optical partitions are coated to decrease transmission.

29. (New) The apparatus according to claim 19, wherein the optical imaging system is constructed on a semiconductor substrate.

30. (New) The apparatus according to claim 19, wherein the optical imaging system and the substrate of the detector structure are made of the same material.

31. (New) The apparatus according to claim 19, wherein at least one of the optical imaging system and the substrate of the detector structure is made at least partially of silicon.

32. (New) The apparatus according to claim 29, wherein the detector structure is applied on a back side of the substrate of the optical imaging system.

33. (New) The apparatus according to claim 19, further comprising:

a membrane supporting the detector structure.

34. (New) The apparatus according to claim 19, wherein the detector structure includes thermocouples.

35. (New) The apparatus according to claim 19, wherein the optical imaging system and the detector structure are formed by joining two wafers prior to sectioning.

36. (New) A method for producing an apparatus for sensing electromagnetic radiation, comprising:

producing an optical imaging system and a detector structure in monolithic micromechanical fashion, the detector structure for sensing the electromagnetic radiation, the optical imaging system for forming an image of a subject to be imaged onto a plane of the detector structure.

REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1-18 in the underlying PCT application PCT/DE99/01869. This Preliminary Amendment further cancels, without prejudice, revised claim 1 in the annex to the International Preliminary Examination Report, and adds new claims 19-36. The new claims, inter alia, conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

The above amendments to the title, the specification and the abstract conform the title, the

specification and the abstract to U.S. Patent and Trademark Office rules, and do not introduce new matter into the application.

The underlying PCT application PCT/DE99/01869 includes an International Search Report, dated January 13, 2000. An English translation of the Search Report is provided herewith.

The underlying PCT application also includes an International Preliminary Examination Report ("IPER"), dated September 19, 2000. An English translation of the IPER is included herewith.

It is respectfully submitted that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

(Reg. No. 36,095)

Dated: 2 Jan 2002

By: _____
Richard L. Mayer
Reg. No. 22,490

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339464

[10191/1694]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)	:	Manfred ROTHLEY et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	APPARATUS FOR SENSING ELECTROMAGNETIC RADIATION
Examiner	:	To Be Assigned
Art Unit	:	To Be Assigned

Assistant Commissioner
for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

SIR:

Kindly amend the above-identified application before examination, as set forth below.

IN THE TITLE:

Please replace the title with the following new title:
--APPARATUS FOR SENSING ELECTROMAGNETIC RADIATION--.

IN THE SPECIFICATION:

Please amend the specification as follows:

On page 1, before line 1, insert:
--FIELD OF THE INVENTION--.

On page 1, line 1, after "The" insert --present--.

On page 1, line 2, change "resolution, as defined in" to --resolution.--.

[10191/1694]

APPARATUS FOR SENSING ELECTROMAGNETIC RADIATION

The invention relates to an apparatus for sensing electromagnetic radiation with local resolution, as defined in the preamble of Claim 1.

Background of the Invention

Present-day semiconductor detectors, for example for infrared radiation, include a detector structure constructed on a semiconductor substrate. In this context, detector arrays comprising so-called thermopile sensors are suitable for detecting infrared radiation. The substrate of the detector structure is usually joined to a housing into which a protective window is set above the detector structure. The protective window is transparent to the radiation that is to be detected, and protects the detector structure from disruptive environmental influences, for example from soiling.

In combination with a spatially resolving detector array, it is possible with such an apparatus to implement an image-producing sensor. Image-producing IR sensors are required, for example, for motor vehicle interior monitoring. An image-producing process requires the provision of an optical imaging system, e.g. an imaging lens, which images onto the plane of the detector array the object that is to be imaged. Conventional imaging lenses with conventional materials represent a considerable cost factor for sensor systems of this kind. Lower-cost plastic lenses are limited in terms of their applicability, since they are, for example, temperature-sensitive.

Advantages of the Invention

In contrast thereto, it is the object of the invention to provide an apparatus for sensing electromagnetic radiation with local resolution for image-producing purposes that can be economically manufactured and installed.

An apparatus according to the present invention is accordingly characterized in that a micromechanically producible optical imaging system is provided. An imaging system of this kind, in particular in the form of a lens, can be manufactured micromechanically from semiconductor material, for example from silicon, in large quantities and economically. The imaging properties and temperature stability of such systems are sufficient, especially in the infrared region, that image-producing sensors can be equipped with them.

In a development of the invention, the micromechanically producible imaging system is joined rigidly to the semiconductor substrate of the detector structure. This join can be made, for example, by installation on a protective housing for the detector structure. Because of the rigid join to the detector structure, the apparatus according to the present invention is ready to use without additionally necessary alignment of the imaging system, thus decreasing the installation outlay for the detector apparatus at the place of use.

A micromechanically producible optical imaging system according to the present invention can, for example, include multiple lenses, thus making such an imaging system suitable in particular for the use of a detector structure having multiple separate detector elements. It is particularly advantageous in this context to associate one lens with each detector element. In a development of this embodiment, the optical axes of the individual lenses are differently oriented, thus yielding a large coverage angle for monitoring of an area.

The combination of one group of detector elements each with one or more lenses is also advantageous depending on the application, for example once again to achieve a large coverage angle for a detector structure made up of multiple detector elements, or to achieve local resolution for a group of detector elements.

In a further advantageous development of the invention, the optical imaging system is used simultaneously as a protective window for the detector structure. A separate protective window thereby becomes superfluous, and the apparatus according to the present invention becomes more economical.

In an embodiment with a protective housing, the optical imaging system (e.g. one or more micromechanical lenses) is thus preferably attached in place of the former protective window in the corresponding mount of the protective housing.

Other configurations are, however, certainly also conceivable; for example, the micromechanical imaging system can be joined via spacers to the substrate of the detector structure.

Such a join can be brought about, for example, by adhesive bonding or by anodic bonding, etc. All known and future types of join in the semiconductor field, in particular in the context of silicon, can be used for this purpose.

A so-called lens array made up of multiple lenses, as set forth above, can be joined rigidly to the detector array with small spacing tolerances, for example using micromechanical spacers as intermediate supports. A rigid join makes the apparatus ready for use without further alignment.

Individual detector elements of a detector structure can be separated from one another by optical partitions. These partitions, which can be constituted, for example, by the surface of an intermediate support configured, for example, in honeycomb fashion, can prevent any undesirable cross-coupling of radiation onto an adjacent detector element. An intermediate support of this kind is preferably made of an infrared-opaque material such as, for example, Pyrex glass.

To decrease transmission through such a partition, a corresponding coating of the partition can also be provided.

As discussed above, the micromechanical imaging system is preferably constructed on a semiconductor substrate. In

addition to economical manufacture, this yields the additional advantage that the substrate of the imaging system can be effectively joined to the substrate of the detector structure, for example using one of the capabilities referred to above.

It is particularly advantageous in this context if the substrate of the optical imaging system and the substrate of the detector system have the same material, so that a join between the substrates is readily possible. If applicable, a spacer can also have the same material. The use of silicon is particularly suitable in this context.

In a further advantageous embodiment of the invention, the detector structure is applied on the back side of the substrate of the optical imaging system. This allows a particularly compact detector apparatus to be realized. In this context, as in the previous exemplary embodiment with spacers, the detector structure can be placed as a separate structure onto the substrate of the imaging system and joined to it. In this embodiment as in the example described above with spacers, alignment of the imaging system with respect to the detector can already be performed at the wafer level, before the individual sensors are sectioned. This means that two wafers having a plurality of micromechanical imaging systems and a plurality of detector structures are aligned with respect to one another and attached to one another before the individual sensors are separated by cutting the wafers. Alignment can thus be performed in particularly simple and highly accurate fashion.

In a further advantageous embodiment of the invention, the detector structure is constructed on the back side of the substrate of the imaging system as a monolithic construction. In this case, the complete arrangement comprising the imaging system and detector structure is constructed on one wafer. This embodiment would be, so to speak, the most highly developed variant embodiment of the invention, with correspondingly great advantages in terms of manufacturing outlay and alignment.

With a monolithic construction as described above, a detector structure that is irradiated from the back side is advisable. This means that the substrate on which the detector structure is constructed must be transparent to the radiation being detected.

In order to construct known thermopile sensors with this procedure, it is advisable to construct a membrane made, for example, of silicon nitride, in order to prevent excessive thermal diffusion of the heat created upon incidence of the radiation that is to be detected. That heat is detected by corresponding thermopile elements. A membrane of this kind can be produced in monolithic fashion, for example, by anisotropic etching of a cavity and/or by etching out a porous layer. All suitable micromechanical production methods, in particular including future manufacturing methods, can be used for this purpose.

Exemplary Embodiments

Several exemplary embodiments of the present invention are depicted in the drawings, and will be explained in more detail below with reference to the Figures, in which:

Figure 1 shows a schematic sectioned depiction of a first variant embodiment of the invention;

Figure 2 shows a depiction, corresponding to Figure 1, of a second variant embodiment;

Figure 3 shows a corresponding depiction of a third variant embodiment;

Figure 4 shows a further embodiment of the invention using monolithic construction; and

Figure 5 shows a particular embodiment with a so-called lens array.

Apparatus 1 as shown in Figure 1 includes a mounting plate 2 on which a substrate 10 having a detector structure 3 is constructed. Detector structure 3 is depicted in simplified fashion and can contain, for example, a plurality of thermopile sensors.

A protective housing 4 covers detector structure 3 and protects it from disruptive environmental influences, for example from soiling. Above detector structure 3, a micromechanical lens 5 is fitted in protective housing 4 as a protective window. Through this, an image-producing method can be carried out using apparatus 1. The image-producing properties resulting from lens 5 are indicated schematically by two beams 6.

A separate lens can be dispensed with in this embodiment, thus allowing the elimination not only of material outlay but also of complex alignment. In addition, a micromechanical lens 5 in accordance with the exemplary embodiment can be economically manufactured in large quantities.

The developed exemplary embodiment in Figure 2 shows once again an apparatus 1 according to the present invention, micromechanical lens 5 being joined, without a protective housing, via spacers 7 to substrate 10 of detector structure 3. In this Figure, a cavity 8 is indicated beneath detector structure 3, so that substrate 2 forms a thin membrane 9 in the region of detector structure 3. The thin membrane 9 prevents excessively rapid dissipation of the heat resulting from the incident radiation. This heat is detected by the thermopile elements. Because thermal diffusion is limited by the thin configuration of membrane 9, the sensitivity of apparatus 1 is thus improved.

The configuration as shown in Figure 2 can be produced in such a way that by production engineering alone, the alignment between lens 5 and substrate 2 is performed simultaneously for a plurality of components each present on a wafer. After the join between lens 5 and substrate 2 has been made via spacers

7, sectioning can then occur, each sensor apparatus 1 being equally well-aligned.

In the apparatus as shown in Figure 3, membrane 9 of detector structure 3 is already directly joined to substrate 10 of micromechanical lens 5. Micromechanical lens 5 is configured as a convexity on substrate 10, while membrane 9 is applied on the back side of substrate 10. Membrane 9 with detector structure 3 can, for example, be constructed separately and then joined to substrate 10 of lens 5, for example by bonding or adhesion. Here as in the aforementioned exemplary embodiment according to Figure 2, alignment and joining are possible simultaneously for a plurality of components by fitting together two wafers before the individual sensors 1 are sectioned. The embodiment shown in Figure 3 represents the smallest construction, among the exemplary embodiments described, for an apparatus according to the present invention.

In a development of this embodiment, the entire apparatus 1 is constructed monolithically on a substrate by micromechanical production methods. In the embodiment shown in Figure 3, cavity 8 is located between the back side of lens 5 and membrane 9. With monolithic construction, this cavity must be configured after production of the membrane. This can be done by etching, for example anisotropic etching or etching of a porous layer provided for the purpose (a so-called sacrificial layer). Once again, all presently known or future micromechanical manufacturing techniques are available for the monolithic procedure.

The depiction in Figure 4 shows an embodiment using the monolithic procedure comparable to the above example, cavity 8 being created in the interior of substrate 10 so that membrane 9 and detector structure 3 are located on the flat back side of substrate 10.

In Figure 3 and Figure 4, detector structure 3 is indicated on the back side of membrane 9, as it would be provided in the case of a monolithic procedure. In such a case it is important

to ensure that membrane 9 is transparent to radiation 6 that is to be detected.

In the case of an infrared sensor it would be suitable, for example, to use silicon as the substrate material. Silicon would furthermore also be a suitable material for the exemplary embodiments mentioned earlier, both for the construction of detector structure 3 as substrate 10 and for the construction of micromechanical lens 5. Silicon is a comparatively inexpensive semiconductor, and thus makes possible economical manufacture of the apparatus according to the present invention.

Figure 5 shows an embodiment of an apparatus according to the present invention having a lens array 11 that has multiple lenses 12 lying next to one another.

Detector structure 3 includes a variety of detector elements 13 that lie on a membrane 9. In order to decrease dissipation of the heat to be detected by detector elements 13, a cavity 8 has been produced in substrate 10.

Micromechanical lens array 11 is rigidly joined, via spacers 7 and intermediate supports 14 surrounding detector elements 13, to detector structure 3; partitions 15 of intermediate supports 14 are configured to be opaque to infrared radiation in order to prevent cross-coupling of heat radiation onto an adjacent detector element 13. The schematically indicated optical axes 16 of the individual lenses 12 of lens array 11 are inclined with respect to one another so that different solid angle regions can be imaged onto the detector elements.

Intermediate supports 14 are preferably configured in honeycomb form, so that they can be constructed next to one another in planar fashion without interstices.

Claims

1. An apparatus for sensing electromagnetic radiation, in particular with local resolution for image-producing sensors, a detector structure constructed on a semiconductor substrate and a protective window for the detector structure being present,
characterized in that a micromechanically producible optical imaging system is provided.

2. The apparatus as defined in Claim 1,
characterized in that the optical imaging system has a micromechanically producible lens (5).

3. The apparatus as defined in one of the foregoing claims, characterized in that optical imaging system (5) is joined rigidly to the detector structure (3).

4. The apparatus as defined in one of the foregoing claims, characterized in that the detector structure includes multiple separate detector elements and the optical imaging system includes multiple lenses, one lens being associated with each detector element.

5. The apparatus as defined in one of the foregoing claims, characterized in that one or more lenses are provided for each group of detector elements.

6. The apparatus as defined in one of the foregoing claims, characterized in that the optical imaging system (5) forms the protective window.

7. The apparatus as defined in one of the foregoing claims, characterized in that the optical imaging system (5) is set into a protective housing (4).

8. The apparatus as defined in one of the foregoing claims, characterized in that spacers (7) are provided between the substrate (10) of the detector structure (3) and the optical imaging system (5).

9. The apparatus as defined in one of the foregoing claims, characterized in that individual detector elements are separated from one another by optical partitions.

10. The apparatus as defined in one of the foregoing claims, characterized in that the optical partitions are coated to decrease transmission.

11. The apparatus as defined in one of the foregoing claims, characterized in that the micromechanical optical imaging system (5) is constructed on a semiconductor substrate.

12. The apparatus as defined in one of the foregoing claims, characterized in that the micromechanical imaging system (5) and the substrate of the detector structure (3) are made of the same material.

13. The apparatus as defined in one of the foregoing claims, characterized in that the micromechanical imaging system and/or the substrate (10) of the detector structure (3) are made at least partially of silicon.

14. The apparatus as defined in one of the foregoing claims, characterized in that the detector structure (3) are **[sic]** applied on the back side of the substrate (10) of the optical imaging system (5).

15. The apparatus as defined in one of the foregoing claims, characterized in that a membrane (9) is configured as the support of the detector structure (3).

16. The apparatus as defined in one of the foregoing claims, characterized in that the detector structure (3) includes thermocouples.

17. A method for producing an apparatus as defined in one of the foregoing claims,
characterized in that the optical imaging system (5) and the detector structure (3) are produced by joining two

wafers prior to the sectioning of individual apparatuses (1).

18. A method for producing an apparatus as defined in one of the foregoing claims,
characterized in that the optical imaging system (5) and the detector structure (3) are produced in monolithic micromechanical fashion.

Abstract

The present invention proposes an apparatus (1) for sensing electromagnetic radiation with local resolution for image-producing sensors that can be economically produced and installed. This is achieved, according to the present invention, in that a micromechanically producible optical imaging system (5) is provided.

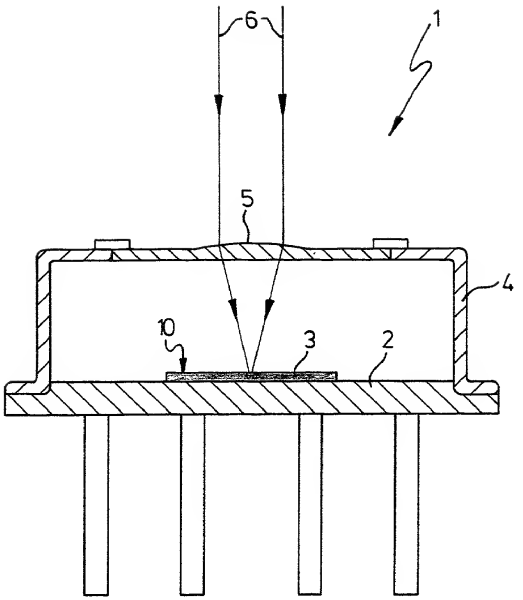

Fig.1

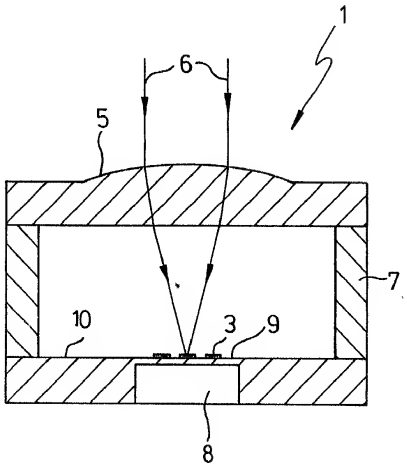

Fig. 2

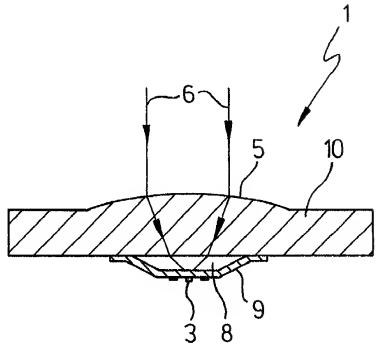

Fig. 3

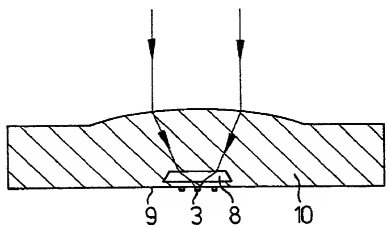

Fig. 4

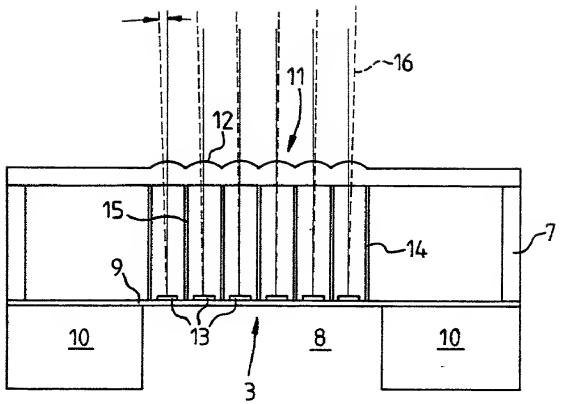

Fig. 5

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COMBINED DECLARATION AND
POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **APPARATUS FOR SENSING ELECTROMAGNETIC RADIATION**, and the specification of which:

[ ] is attached hereto;

[ ] was filed as United States Application Serial No. _____ on _____, 19__ and was amended by the Preliminary Amendment filed on _____, 19__.

[x] was filed as PCT International Application Number PCT/DE99/01869, on the 26th day of June, 1999

[x] an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

EL302704031

PRIOR FOREIGN/PCT APPLICATION(S)
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119

Country : Federal Republic of Germany

Application No. : 198 29 027.6
199 23 606.2

Date of Filing: 30 June 1998
25 May 1999

Priority Claimed
Under 35 U.S.C. § 119 : [x] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code § 120 of any United States Application or PCT International Application designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR
PCT INTERNATIONAL APPLICATIONS
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. § 120

U.S. APPLICATIONS

Number :

Filing Date :

PCT APPLICATIONS
DESIGNATING THE U.S.

PCT Number :

PCT Filing Date :

I hereby appoint the following attorney(s) and/or agents to prosecute the above-identified application and transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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